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DOE Laboratory Overviews
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Ames National Laboratory

The Simulation, Modeling, and Decision Science Program at the Ames Laboratory is focused on the fundamental research question of how to improve decision making and learning for complex systems in which energy, people, and the environment meet. Within this broad domain our research seeks to address two questions:

- How do we readily use the information from disparate sources (e.g., models, data, and other information elements) that must be integrated together to create decision-making environments that can accurately represent the fidelity and breadth of a complex system?
- How can we integrate the analytical decision-making process with a more natural, engaging, and user-centered decision-making process?

That is, we are seeking to develop understandings and tools that create engaging and practical decision-making environments that enable humans to interact with each other and reach collaborative decisions about the critical complex systems within our world. Our approach to this effort is built on the natural decision-making processes and tools humans use in their everyday lives. Specifically, we are developing federated model sets as a tool for end-to-end modeling of complex systems; examining narrative, paradata, and metaphor as tools to enable human engagement; and developing cyber-physical devices as engineering and designing tools for complex energy systems.

Collaboration—We welcome the opportunity to collaborate on projects that utilize our research skills in information/model integration, decision science, narrative theory, and information science and are focused on

- end-to-end modeling of complex systems,
- the integration of narrative and metaphor into human-decision making systems,
- integrated computational environments, or
- the application of various tools (e.g., augmented reality, virtual reality, wearables) to decision making.

In addition, we use virtual/augmented reality, computer visualization, and human computer interaction in support of our core research interests, and we often collaborate with other groups in these areas.

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Argonne National Laboratory

Argonne National Laboratory is a leader in developing science and technology solutions for resilient critical infrastructure systems that enhance community resilience and reduce risks to lives and property. Argonne researchers are studying the cascading and escalating impacts among critical infrastructure through comprehensive analysis of upstream, internal, and downstream dependencies. The resiliency of these systems depends on the linked contributions from all aspects that make up the communities that rely on them—physical infrastructure, socioeconomic and behavioral elements, and environmental factors. Hence, a key component of Argonne's infrastructure resilience analysis involves researching the human dimension of critical infrastructure systems – the ensemble of human actors that includes decision makers, developers, owners, operators, regulators, and those impacted by the systems. Argonne researchers are utilizing a variety of modeling and simulation approaches, advanced data analytics, and systems science methods to study how to enhance the resiliency of communities and provide decision makers with actionable courses of action. Argonne's interests are highly collaborative – reaching across government research organizations (federal, state, and local), industry, and academia to assemble powerful interdisciplinary teams.

Idaho National Laboratory: The Human Systems Simulation Laboratory

The Human Systems Simulation Laboratory (HSSL) was created at Idaho National Laboratory (INL) in 2012 as a full-scope, full-scale control room simulator facility to support research on nuclear power plant control room modernization (Boring et al., 2013). The facility consists of an observation gallery and control room. The control panels consist of 15 touchscreen bays, each with three to four displays, which allow representation of the full front panels of current U.S. main control rooms at nuclear power plants. These control rooms are currently largely analog, and the glasstop simulator presents such analog instrumentation and controls as functional, dynamic mimics on the displays. Because of the virtual nature of the simulator, it is also possible to introduce representations of new digital human-machine interfaces (HMIs) that will replace the existing boards. Researchers at INL develop prototypes of new HMIs and benchmark performance of reactor crews using the existing vs. new boards. These operator-in-the-loop design studies have also yielded considerable process insights, resulting in new human factors techniques like the Guideline for Operational Nuclear Usability and Knowledge Elicitation (GONUKE; Boring et al., 2015), which outlines methods and measures for verification and validation of control system upgrades.

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Los Alamos National Laboratory- Engineering Institute

The LANL-Engineering Institute works on the development for novel human-machine interfaces for structural health monitoring, structural inspection, glovebox safety and robotics applications. Specific areas we are exploring is the use of the phenomena of sensory substitution to communicate data collected by distributed sensor networks to humans while they are actively engaged in other tasks. We are also interested in extending the reach of human senses using robotics. Specifically, we are exploring the ability to use drones to facilitate structural inspections that would normally require that an inspector use a crane or rigging to inspect difficult-to-access parts of the structure. We are also interested in using augmented reality for these applications. Finally, we are actively involved in research to synthesize artificial personalities. We are looking for possible areas to collaborate on all of these topics.

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Oak Ridge National Laboratory

The Oak Ridge National Laboratory (ORNL) has a number of R&D efforts aiming to understand the factors and processes impacting cognitive, behavioral, social, and physiological well-being in real-time and across the human lifetime. Scientific activities are in four key areas: (1) data capture technologies to quantify the human and its environment across spatial and temporal scales; (2) big data analytics to accelerate knowledge discovery and advance the utility of data for individual and public health benefit; (3) infrastructure for data-driven modeling, simulation, and dynamic optimization of the "quantitative human"; (4) social, economic, institutional, and behavioral analyses of the intersections of interacting social, economic, environmental, and technological systems.

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Pacific Northwest National Laboratory

The Pacific Northwest National Laboratory has a User Experience Group that consists of Human Computer Interaction and User Interface Design staff. This group of people is in high demand and work in many domains across the laboratory. They contribute to the collection of user requirements, user interface design, and user evaluation of research and development projects through the laboratory. One of our primary capabilities is in the design and implementation of visual analytics. We develop interactive visualizations that are helpful in exploratory analysis of extremely large datasets. Members of our group participate in work in the power grid, search and rescue operations, design and use of visual analytics, cybersecurity and social media use. Examples of recent projects include:

- The design and evaluation of a model that provides a graphical means to guide users in the evaluation and investigation of identity in a more holistic manner across physical and digital identity attributes.
- The design and evaluation of a suite of visual analytic tools designed to support deep investigation of large multimedia collections. These tools combine the understanding of data represented in multiple formats: video, image, and text and presents that information to users through new visual representations. This has been shown to reduce analysts' workload and ultimately the effort of identifying critical intelligence for decision makers.
- The design and evaluation of an advanced analytic workbench and the mobile applications will 1) improve the understanding of disease baseline and event prediction related to human social, cultural, and behavioral data; environmental/climatological data; disease risk mapping; and 2) enable users to predict, alert, forecast and manage a bio threat event—whether emerging, endemic, or intentionally introduced—within 24 hours to minimize harmful impact to the warfighter and society.
- The implementation of a Scalable Reasoning System (SRS), an analytic framework for developing web-based visualization applications. Using a growing library of both visual and analytic components, custom applications can be created for any domain, from any data source.
- The Shared Perspective Project, part of the Future Power Grid Initiative, designed and implemented an actionable visualization tool for transmission operators to exchange information with neighboring utilities. Rather than relying on phone calls these displays are intended to be shared between regional control rooms to provide operators with a more global situation awareness of the power grid in their region. The displays were designed so that the amount of information being shared could be controlled by each individual control rooms. The display featured a geospatial map view that could be annotated. Iterative designs were produced based on feedback from a number of different operators in various utilities.
- There is a current effort to produce a human-in-the loop model to be used for testing the resiliency of Industrial Control Systems. This model will be used in conjunction with other simulations for testing.
- PNNL is also involved in several other projects involving the power grid. From the human point of view, we are focused on developing visualizations and visual analytics for transmission operators, distribution centers, and eventually home systems that can monitor and utilize various types of power. Another visualization system is looking at data from hydro systems and designing and integration data architecture to make this data browsable in a web system.
- PNNL is also supplying simulation data and tools to examine this data for teams developing algorithms to detect and isolate attacks on the power grid.
- Visual analytics displays have also been developed to take the results of simulations and help control system designers track the effects of various controls.

While some of these efforts are not direct studies of human cognition, the efforts in visual analytics focus on designing interactive visual systems that have been shown to facilitate humans in the exploration and analysis of large systems.

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Sandia National Laboratories

Sandia National Laboratories (SNL) is a multi-program, national security laboratory with explicit missions in nuclear weapons, air and space surveillance and reconnaissance, cyberspace, global nuclear assurance and security, global chemical and biological dangers, and a secure and sustainable energy future. Because each of the complex systems associated with these missions are also sociotechnical, SNL endeavors to design them with the human as a key element— either as a supervisor/operator, system component, subject, or an inspiration. Understanding humans in these roles is critical to designing effective systems and processes from theory to end-user. As both a research and engineering laboratory, Sandia can move products from concept to component to completion.

Though Enhanced Decision-Making and the Human Factors groups lead the charge, more than 130 people in 14 different Centers throughout SNL conduct research and/or apply techniques to maximize performance of human and human-machine systems. SNL human dimension work integrates multiple disciplines including but not limited to psychology and psychophysiology, neuroscience, sociology, economics, ethics, systems-and nano-biology, physics, engineering, computer science, and data analytics.

Interdisciplinary teams strive to integrate research efforts with mission need to produce new capabilities. For example, SNL applies its work in basic visual cognition and expert/novice behaviors to develop effective data visualization and analysis tools for analysts and operators in air and space surveillance, cyber security and public safety. Overarching interests include: understanding and augmenting human performance from biophysical, cognitive, behavioral and HMI perspectives, neuromorphic computing, systems resilience in areas like power grid and nuclear security operations, risk identification and mitigation in high consequence/low probability environments, and developing effective learning/training paradigms.

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.